Before the

Federal Communications Commission

Washington, D.C. 20554

In the Matter of	)	
Promoting More Efficient Use of Spectrum Through Dynamic Spectrum Use Technologies	))	ET Docket No. 10-237

Comments of Key Bridge Global LLC

Key Bridge is pleased to provide our perspective in response to the many questions posed by the Commission in its Notice of Inquiry.[1] Below we provide our opinion and observation about Commission structured market incentives and we present a purposefully creative discussion of options and actions the Commission might consider as it seeks to improve the efficiency of spectrum employment in the United States. We hope the Commission finds our comments helpful and constructive.

1. Introduction and Problem Statement

The American public is migrating to small and medium screen, mobile platforms (e.g. smart phone, tablet PC, etc.) as a preferred portal to access and consume Internet resources. Simultaneously, the American public is also rapidly shifting to wireless access for all types of communication, including voice telephony, interactive data and video entertainment. Wirelessly accessed Internet resources can range from entertainment to business applications to safety-of-life emergency communication. It goes without saying that wireless communications are increasingly important to the American public and the FCC has an obligation to ensure that spectrum resources are deployed to meet the nation's needs as efficiently as possible.

2. Current situation

Of the 275,000 MHz under US Government management[2], an overwhelming majority (literally billions) of consumer electronic devices may access less than 500 MHz of total spectrum for all of their wireless access and broadband needs. It could be argued that less than 1/5th of 1% of the nation's wireless spectrum resources are deployed for the day-to-day benefit of an average citizen's entertainment, convenience, safety or productivity.

[1] See *Notice of Inquiry: Promoting More Efficient Use of Spectrum Through Dynamic Spectrum Use Technologies* (NOI), ET Docket 10-237

[2] See *FCC Online Table of Frequency Allocations*, 47 C.F.R. §2.106 Revised on July 26, 2010, which begins at 9.0 kHz and ends at 275 GHz

Key Bridge Global LLC
1600 Tysons Blvd., Suite 450, McLean, VA 22102
Phone: +1 (703) 414-3500
http://KeyBridgeGlobal.com

As background, a (non-exclusive) summary of the most commonly used and recognized frequency allocations is listed below which represent a vast majority of consumer electronic device access.

2.1. Unlicensed Allocations

Unlicensed allocations typically support ISM Equipment or other Part-15 type devices, the most popular and best known being consumer Wi-Fi.

Frequencies	Bandwidth	Common Use
0.902 – 0.928 GHz	20 MHz	Cordless Phones, ZigBee
2.400 – 2.4835 GHz	83.5 MHz	802.11b/g/n
3.65 – 3.70 GHz	50 MHz	802.11y
5.15 - 5.35 GHz	200 MHz	U-NII
5.725 – 5.850 GHz	125 MHz	802.11a/h/j/n
Total	478.5 MHz	

2.2. Licensed Allocations

The most popular and publicly known licensed allocations are used for cellular communication.

Frequencies	Bandwidth	Common Use
824.0 - 849.0 and 869.0 - 894.0 MHz	50 MHz	GSM 850
896.0 - 901.0 and 935.0 - 940.0 MHz	10 MHz	GSM 900
1850.0 - 1910.0 and 1930.0 - 1990.0 MHz	60 MHz	PCS 1900
Total	120 MHz	

3. Discussion

Beginning with the Commission's first ISM assignment in 1985, wireless innovation has bloomed as a direct result of unlicensed spectrum availability. Within these bands unlicensed devices are required to be tolerant of ISM emissions and may not interfere with licensed users. As a direct result of this flexible guidance, commercial innovation has largely resolved most spectrum sharing, coexistence and interference avoidance issues through new and ever improving developments that extend wireless broadband networking to billions of consumer electronic devices worldwide.

Within some licensed frequency bands benefiting from sufficient scale wireless innovation has also been driven through extensive investments by wireless carriers as consumer demand for increased bandwidth and services has increased. Cellular telephony innovation has created sophisticated spectrum reuse and network management technologies that also support billions of consumer electronic devices worldwide with fully mobile wireless voice and low-speed data networks.

We observe that the number and variety of radio devices operating in the unlicensed ISM bands (especially at 2.4 GHz) exceed the number of devices certified to operate any other band by

Key Bridge Global LLC
1600 Tysons Blvd., Suite 450, McLean, VA 22102
Phone: +1 (703) 414-3500
http://KeyBridgeGlobal.com

almost three times. For reference, our investigation shows the top five most populated frequency bands by device certification are:

Lower Frequency (MHz)	Upper Frequency (MHz)	Certified Devices In Band	Typical Application
2402	2480	20,339	WIFI Networking
88	108	7,275	FM Radio
1850.2	1909.8	5,552	PCS 1900
0.535	1.605	5,149	AM Radio
824.2	848.8	3,933	GSM 850
60	72	2,363	Set Top Box (TV Ch 2,3)
433.92	433.92	2,090	Keyless Entry

We believe product availability is a good indicator of the market signals driving investment and innovation in wireless services and the above table leads to the conclusion that wireless innovation gravitates to unlicensed spectrum bands where device manufacturers may freely compete for market share by delivering improvements in device value and wireless network quality, performance and efficiency.

In October 2010 the Commission presented various industry projections for mobile wireless data traffic which anticipate compound annual average growth approaching 100% per year for the foreseeable future.[3] Key Bridge concurs with the Commissions observations that, in general, the American consumer will demand increasing access to low cost, high speed, mobile data networks (e.g. 3G, 4G and beyond) and continue to deploy or upgrade personal wireless networks based on high-speed unlicensed spectrum technology (e.g. WiFi in the home and office).

However, we are generally skeptical of accelerating growth curves with slopes approaching vertical and also do not draw the conclusion that an increase in wireless data use should map directly to an increase in spectrum allocation for this purpose. While we do not offer technical justification here, our experience leads us to believe that a 35x increase in aggregate data traffic may be achieved with less than a 35x increase in direct spectrum allocation for data networking. To wit:

- We do not believe industry has reached the limits of ISM band performance and deployment: 802.11 development is still going strong, and has not approached the limits of geographic frequency reuse.
- We do not yet now the impact of emerging VHF/UHF data services, where we believe early deployments are likely to provide asymmetric content distribution network (CDN)

[3] See *Mobile Broadband: The Benefits of Additional Spectrum*, OBI Technical Paper No. 6, Federal Communication Commission Omnibus Broadband Initiative, at 9 (Oct. 21, 2010).

Key Bridge Global LLC
1600 Tysons Blvd., Suite 450, McLean, VA 22102
Phone: +1 (703) 414-3500
http://KeyBridgeGlobal.com

overlays to other wireless networks like 3G/4G.[4] Examples of as-yet untapped opportunities for wireless broadband distribution include the newly available TV band white spaces and we are also very interested to see how AT&T employs their recently acquired 700 MHz licenses.

- We observe that many licensed wireless services have yet to take advantage of many now standard technologies and techniques developed for the ISM unlicensed bands including OFDMA waveforms and MIMO.[5]

It may therefore be a productive exercise for the FCC (singularly or perhaps in cooperation with the National Science Foundation) to commission a series of formal studies to investigate how qualitative and quantitative improvements may be achieved to extend a given spectrum's utility. For example, considerable improvements in network utility may be achieved when various sharing strategies are implemented (e.g. frequency, space, time, coding, and modulation). Such improvements may manifest, for example, as the ability to support an increased number of simultaneous users, improvements in link performance (e.g. throughput, delay), and increased ability to simultaneously support a broader mix of applications.[6]

As a practical matter, spectrum by itself has limited value. Only when transformed into a tangible and useful service does wireless spectrum become a valuable component in an end-to-end communication system. We understand the Commission's implied goals within the NOI is to investigate aspects of a regulatory framework and licensing environment that may allocate sufficient spectrum for broadband wireless networks and higher-speed mobile data services to meet the public's evolving needs. To achieve this goal Key Bridge suggests the Commission consider two parallel strategies:

First, the Commission might recognize industry's natural inclination to develop, and consumer's readiness to purchase and use, wireless products that operate on unlicensed frequencies. To foster innovation in radio technologies we therefore recommend the Commission investigate opportunities for permanently extending unlicensed use into new bands.

In its NOI the Commission identified several ideas for identifying and evaluating dynamic access in new bands, including providing "access … for some period of time … before offering that spectrum for re-auction."[7] Metaphorically and with respect, renters typically do not remodel their apartments. Similarly, we feel that temporary access to a frequency band, however liberal, is not likely to produce any substantive innovation and we discourage the Commission from such an exercise. Rather, Key Bridge believes that, as clearly demonstrated with the ISM bands, only a

---

[4] Many wireless carriers already offer free public and "subscriber only" WIFI networks, encouraging their users to access the Internet via unlicensed broadband networks instead of their licensed cellular networks. For example, see *O2 plans free WiFi for all in UK* at http://www.totaltele.com/view.aspx?ID=461834

[5] *Orthogonal Frequency-Division Multiple Access* (OFDMA) is an advanced digital modulation scheme supporting multiple users with robust accommodations for multi-path interference. *Multiple-input and multiple-output* (MIMO) is a smart antenna technology employing multiple transmit and receive antennas to improve communication performance.

[6] See *Assessment of Gain Improvements due to Packet versus Circuit Switching*, National Reconnaissance Office, Transformational Communications Architecture White Paper, May 2003 at 4.

[7] See *NOI* at pp 43, page 16.

Key Bridge Global LLC
1600 Tysons Blvd., Suite 450, McLean, VA 22102
Phone: +1 (703) 414-3500
http://KeyBridgeGlobal.com

permanent unlicensed designation will provide sufficient flexibility and predictability for the risk capital necessary to achieve the technological innovation and development the Commission desires.

In the coming months and years the Television White Spaces may provide the Commission with a useful case study for how, and how much, innovation and private investment are stimulated by newly available unlicensed spectrum. We encourage the Commission to watch the TV White Spaces closely as a potential model for extension into other bands.

Second, we suggest that industry and consumers might better recognize that mobility requires ubiquitous service and that low-cost mobility cannot be achieved without a wireless network service provider with sufficient scale.[8] To increase the quality and quantity of mobile data networking we therefore recommend the Commission explore opportunities to increase the amount of contiguous nationwide spectrum available for auction to licensed service providers.

However, due to the nature of mobile data traffic flows and the propagation characteristics of VHF/UHF frequencies, we also wish to caution that Key Bridge is not convinced the discussions around "repacking" the UHF band below 700 MHz will provide improvements in mobile data services.

4. Quantify the need

As stated above, Key Bridge believes the Commission may benefit from a series of formal, peer-reviewed studies that investigate the status quo, historical context and applicable analogies to other data networking markets (e.g. dial up, DSL, cable modem, FIOS), and provide better understanding of wireless data traffic profiles.

The FCC might seek to better understand the operational statistics of wireless data consumption and consumer behavior, and use this information to inform its own policies and licensing schemes to provide sufficient flexibility to meet this real-world demand.

For example, we suspect that current mobile data traffic (e.g. traffic servicing handsets, smart phones and tablets, etc.) is likely to be highly asymmetric favoring outbound flows from the network to the consumer of as high as 8 or 16 : 1, effectively making consumer wireless broadband look more like a "shared bearer" broadcast service.[9] Such asymmetries will likely reduce but not equalize as upstream bandwidth increases, 2-way applications become more populate and interactive applications become less bandwidth sensitive (i.e. become more sloppy in their network resource utilization).

5. Stimulate Innovation through Expanded Access to Unlicensed Spectrum

[8] As a case in point, unlicensed WiFi networking may be free, but because no nationwide WiFi network service providers exist WiFi roaming (e.g. paid access hotspots) can be significantly more expensive than typical mobile data.

[9] By shared bearer we mean a scenario similar to a DOCSIS outbound channel or certain shared bearer satellite services, where packets are uniquely addressed to a subscriber's device and multiplexed within a common broadcast. Various similar scenarios are used by the subscriber to filter the incoming packets depending upon protocol. For example in DOCSIS only packets with the cable modem's MAC address are read, all others ignored, and in satellite systems an MPEG-2 PID is often used.

Key Bridge Global LLC
1600 Tysons Blvd., Suite 450, McLean, VA 22102
Phone: +1 (703) 414-3500
http://KeyBridgeGlobal.com

Key Bridge believes the market statistics clearly show that wireless innovation is fostered by access to unencumbered spectrum resources and we feel the best policies the Commission might implement to stimulate dynamic radio technologies is through permanent expansion of unlicensed access into additional frequency bands.

We believe there are many bands that could readily support dynamic spectrum access strategies, and suggest the Commission use its experience in developing the rules for TV bands white space as a model for effective coexistence between unlicensed devices and licensed incumbents in other bands.

Key Bridge respectfully declines at this time to recommend any specific bands. We do suggest however that a comprehensive and long-term spectrum inventory would provide more than enough information for the Commission to identify vacant or underused bands for spectrum sharing, to accurately quantify and trend incumbent occupancy and use in those bands, and to establish flexible use rules that enable unlicensed access while providing effective interference protection for incumbent licensed services. Again we suggest the Commission consider TV bands as a guiding example for such implementations.

6. Expand the Utility of Licensed Spectrum and Commercial Wireless Service Providers

As stated previously, we believe that many licensed wireless services have yet to take advantage of many of the performance improvements and innovations flowing out of the unlicensed bands. One concept the Commission may investigate is to establish, on a case-by-case basis, a target efficiency level for wireless spectrum users and systems. For example, the FCC has been working to improve the efficiency of public safety communications, reducing their VHF/UHF channel bandwidth from 25 to 12.5 kHz, a process which effectively doubles user density and creates a de-facto requirement for improved out-of-band emission masking.[10]

The commission could extend this concept to make recommended or required minimum performance or efficiency standards on wireless use licenses in other bands.

We respectfully decline at this time to speculate on what such standards would look like or against which technical parameters the Commission might set minimum thresholds. Rather, this might serve as the topic of another peer-reviewed study.

7. Don't Count on Secondary Markets

Blockbuster deals like AT&Ts $1.9B purchase of spectrum rights from Clearwire notwithstanding, Key Bridge does not believe there currently is a credible or viable market in spectrum trading.

First, there is limited economic pain in holding a fallow spectrum use license which encourages speculative licensees and hoarding. The commission might consider reviewing licensee obligations, for example gradually increasing the renewal rate on un-executed licenses or fallow spectrum to match the opportunity cost of a fallow use licensed with the spectrum's actual value.

[10] See FCC Order 05-9, WT Docket No. 96-86, January 7, 2005 and FCC Order 04-292, WT Docket No. 99-87 and RM-9932, December 23, 2004

Key Bridge Global LLC
1600 Tysons Blvd., Suite 450, McLean, VA 22102
Phone: +1 (703) 414-3500
http://KeyBridgeGlobal.com

Second, we observe that spectrum trading has been tried several times before with mixed and often poor results. As examples, we note the valiant but ultimately unsuccessful attempts by Enron, Band-X, RateXchange, the London Satellite Exchange (LSE), and others to create bandwidth and service exchanges. A variety of innovative strategies have been attempted, from fully automated systems to live telephone traders with intimate knowledge of available inventory, coverage, performance, price, and utility. The various strategies all attempted to solve the real economic problem of matching costly or perishable resources to a willing buyer. Unfortunately, none could overcome the basic economic challenges that a wireless spectrum license is not fungible, not liquid, and not transparent, and there exists no standard "trading" unit that secondary markets may use to value a spectrum use right.

If channel bandwidth is product quantity, information about a spectrum's suitability for an application over an area of interest might be considered the equivalent of product quality. Key Bridge believes that secondary markets are also significantly inhibited by a lack of objective information about product quality. For example, to properly price a spectrum right the prospective acquiring (or selling) party should conduct a spectrum survey, which is an expensive process typically done only in advance of wireless deployments. This expense, and if not incurred the associated risk premium, creates significant transaction friction.

Regular data from a permanent spectrum inventory infrastructure might add significant value to prospective buyers and sellers alike and generally help to resolve the product quality issue, thereby serving to generally increase market liquidity.

8. Modernizing Public Safety Communication

Key Bridge believes that public safety communication requirements combine those of the consumer and military user: needing access to ubiquitous broadband but also requiring secure communications that operate under extreme conditions. We suggest the Commission's investigations concerning public safety might benefit from a review of the DOD's numerous research programs for improving tactical communications and for bringing new applications to the warfighter.

Innovative examples of DOD research that the commission (and industry) might leverage to benefit our public safety professionals include the Joint Tactical Radio System (JTRS), a next-generation cognitive voice and data radio system and the US Army's recent investigations into hardened, Android-powered devices and private "AppStore" for innovative, rapid, flexible application and information delivery to the warfighter.

These and other investigations might provide great improvements for public safety communication systems.

9. Conclusion

Key Bridge thanks the commission for this opportunity to share our perspective on this important topic. The Commission's questions are provocative and insightful. To help inform the Commission's decisions we believe one or more peer-reviewed studies may be warranted. We furthermore believe a permanent spectrum monitoring and inventory infrastructure could provide the qualitative and quantitative data the Commission may require.

Key Bridge Global LLC
1600 Tysons Blvd., Suite 450, McLean, VA 22102
Phone: +1 (703) 414-3500
http://KeyBridgeGlobal.com

With regard to driving innovation for dynamic spectrum access and satisfying the American public's need for improved broadband and mobile wireless services, Key Bridge believes that a joint strategy of permanent expansion of unlicensed and licensed spectrum access is sensible.

We believe the TV band White Spaces, and data from a spectrum inventory infrastructure, can further assist and inform the Commission.

Finally, with respect to improving public communications, Key Bridge suggests the Commission investigate possible synergies with the many interesting and substantive tactical communication research and development projects supporting the warfighter.

Sincerely,

/s/

Jesse Caulfield, President

Key Bridge Global LLC

Key Bridge Global LLC
1600 Tysons Blvd., Suite 450, McLean, VA 22102
Phone: +1 (703) 414-3500
http://KeyBridgeGlobal.com

10. Appendix: Analysis of FCC Certified Devices

Key Bridge undertook a brief study of the FCC's equipment authorization data to identify the diversity of devices authorized to operate within various frequency bands. The data included equipment authorizations from 1981 (the oldest records available electronically) to January, 2011.

The complete data set of number of devices by operating frequency is plotted below.

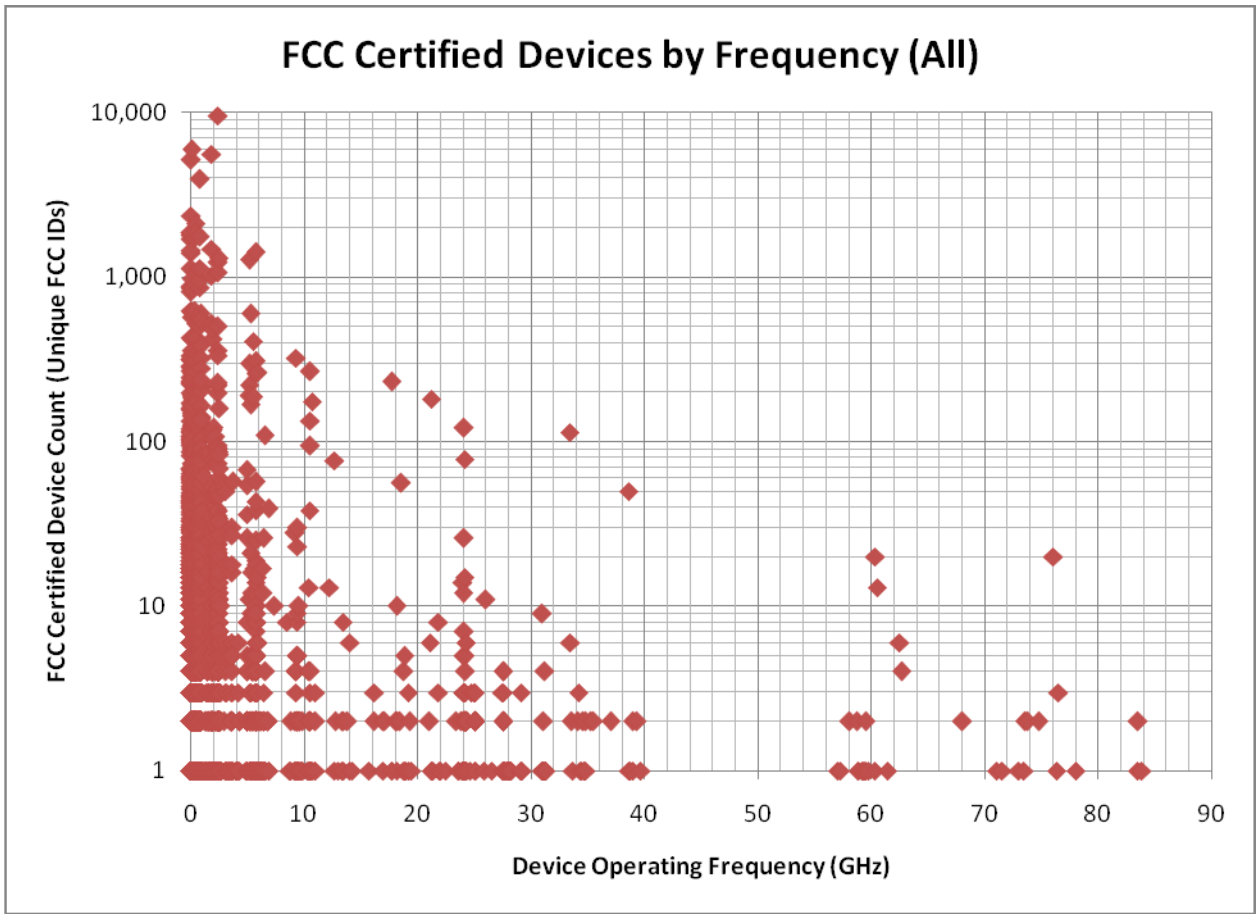

Figure 1: All certified devices by frequency

Key Bridge Global LLC
1600 Tysons Blvd., Suite 450, McLean, VA 22102
Phone: +1 (703) 414-3500
http://KeyBridgeGlobal.com

The complete data set in figure 1 was reduced to highlight certified devices operating below 6.0 GHz. This view of the same data makes clear the relative dominance of certain frequency bands like 2.4 GHz.

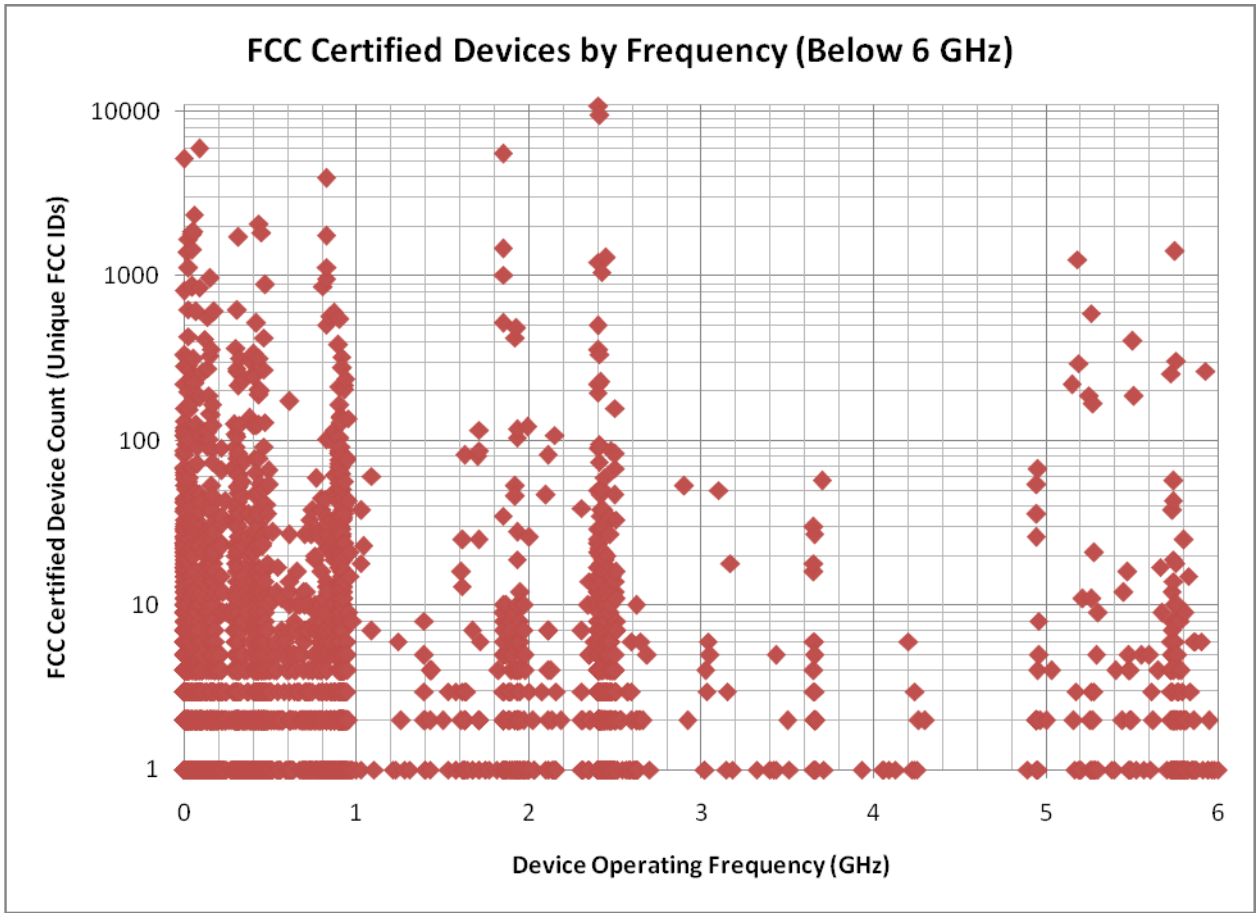

Figure 2: All certified devices by frequency, below 6 GHz

Key Bridge Global LLC
1600 Tysons Blvd., Suite 450, McLean, VA 22102
Phone: +1 (703) 414-3500
http://KeyBridgeGlobal.com

The data in Figure 2 was then re-plotted with a linear scale to highlight the relative position and numerical dominance the top 5 allocations: 2.4 GHz ISM, AM radio, FM radio, GSM 850 and PCS 1900.

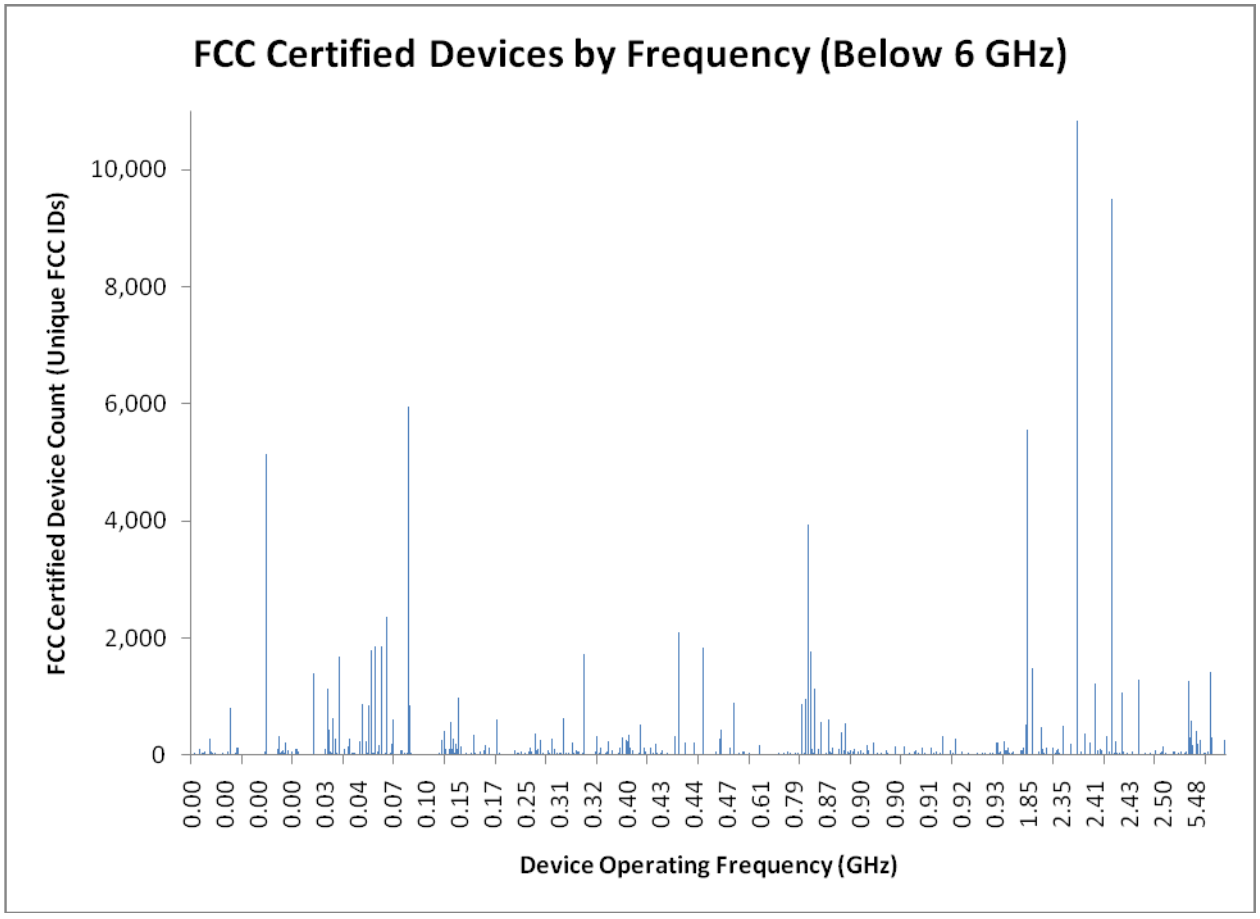

Figure 3: All certified devices by frequency, below 6 GHz, linear scale

Key Bridge Global LLC
1600 Tysons Blvd., Suite 450, McLean, VA 22102
Phone: +1 (703) 414-3500
http://KeyBridgeGlobal.com